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(54) Powder alloy mix and superalloy article repair method.

(57) An alloy is made up from the material of a component which is to be repaired and a material the constituents of which are chosen so as to enable mixing with the material from which the component is made, followed by brazing of the mixture to the component and then diffusion thereinto, without impairing the characteristics of the component. The latter material has the following composition:

Al	2	-	3
Co	9	-	11
Cr	8	-	10
Fe	0	-	1.8
Hf	1.0	-	1.5
Ta	1.0	-	1.5
Ti	1.25	-	1.5
W	6	-	8
B	2.8	-	3.4
Y	0.001	-	0.02
Ni	Remainder		

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ALLOY MIX AND METHOD OF REPAIR OF AN ARTICLE THEREWITH

The present invention relates to an alloy mix suitable for the repair of articles which are used in a high temperature environment. The invention also relates to a method of achieving a repair with the alloy.

According to the present invention an alloy mix suitable for repair of Nickel based alloy articles which are used in a high temperature environment comprises a first alloy, the constituents of which by weight percentage are:

TABLE I

Al	2	-	3
Co	9	-	11
Cr	8	-	10
Fe	0	-	1.8
Hf	1.0	-	1.5
Ta	1.0	-	1.5
Ti	1.25	-	1.75
W	6	-	8
B	2.8	-	3.4
Y	0.001	-	0.02
Ni	Remainder		

mixed with a second alloy, the constituents of which by weight are:

TABLE II

C	.13	-	.17
Al	5.25	-	5.75
B	0.01	-	0.02
Co	9.0	-	11.0
Cr	8	-	10
Hf	1.3	-	1.7
Ta	2.25	-	2.75
Ti	1.25	-	1.75
W	9.5	-	10.5
Zr	0.03	-	0.08
Ni	Remainder		

and wherein the weight percentages of the first alloy to the second alloy is in the range 60:40 to 50:50.

The invention further provides a method of repairing a component with said alloy, which comprises the steps of mixing the alloy with a binder, applying the bound alloy to the component, heating the component in steps to a desired maximum, quenching the component in an inert gas to about 75% of the maximum temperature so reached, reheating the component at a constant rate to several pre-selected values of temperature, interspersed with periods of time which start as each selected temperature is reached including the desired final temperature, inert gas quenching the component to below a given value, followed by cooling the component to room temperature in ambient air.

The invention will now be described, by way of example.

A gas turbine blade (not shown) of the kind which is used in a gas turbine engine and made from a nickel based alloy, frequently has score marks and/or fissures accidentally machined thereon, during an electro discharge machining operation on it.

The score marks must be filled in order to avoid cracking of the blade and to maintain proper flow

conditions over the blade surface when in service.

The filling must be a metal which is compatible with the metal from which the blade is constructed and further, must be workable at temperatures below those which the blade operates in a gas turbine engine and yet, after the repair, must be in a condition which does not result in the filling being lost under those conditions. Thus a first alloy is made up from the following constituents, the quantities of each of which is stated by weight percentage.

TABLE I

Al	2	-	3
Co	9	-	11
Cr	8	-	10
Fe	0	-	1.8
Hf	1.0	-	1.5
Ta	1.0	-	1.5
Ti	1.25	-	1.75
W	6	-	8
B	2.8	-	3.4
Y	0.001	-	0.02
Ni	Remainder		

A second alloy is provided which is made up from the following constituents, again stated by weight percentage. The second alloy is a propriety alloy, sold as MarM002.

TABLE II

C	.13	-	.17
Al	5.25	-	5.75
B	0.01	-	0.02
Co	9.0	-	11.0
Cr	8	-	10
Hf	1.3	-	1.7
Ta	2.25	-	2.75
Ti	1.25	-	1.75
W	9.5	-	10.5
Zr	0.03	-	0.08
Ni	Remainder		

Both of the alloys are ground to a powder, the size of the particles of which is less than 106 um.

The powders are then mixed thoroughly by any known and convenient means, to provide in powder form, an alloy mix in the ratio 60:40 to 50:50 by weight of the first and second alloys repectively.

As stated hereinbefore, the filling must be compatible with the metal from which the component is made. Thus, the alloy mix of the resent invention may be used to effect a repair of a component which is made from MarM002.

To enable applications of the powdered alloy mix into the fissure or score mark, it is further mixed with an acrylic or water based binder of any suitable, freely available type and is then loaded into a syringe, use of which also ensures accuracy of position and quantity applied.

After cleaning the component, the powder mix is applied to the fissure via the syringe and then the component is placed in an vacuum furnace, which then purged of air, so as to avoid oxidising of the assembly.

A heating and cooling cycle is then effected as follows:

a) Heat to 450°C and hold for 30 minutes.

b) Increase to 950° and hold for 30 minutes.

c) Increase to 1190°C and hold for 30 minutes. The increases in heat should be achieved as quickly as possible, such that they are effectively steps.

d) After holding the temperature at 1190°C for 30 minutes, the component is gas fan quenched to 900°C and thereafter, the heat is again increased, this time with a specific rate of increase as follows:

e) Heat from 900° up to 1080°C at 50° per hour and hold for 30 minutes.

f) Heat from 1080°C up to 1140°C at 50°C per hour and hold for 30 minutes.

g) Heat from 1140°C to 1190°C at 50° per hour and hold for 30 minutes.

h) Gas fan quench to below 100°C and then to room temperature in ambient room atmosphere.

The first mentioned heating and quenching effects alloying of the two alloys and brazing of the resulting alloy to the component. The second mentioned heating steps effect diffusion of the new alloy and the material of the component across the interface, so as to provide an integral product.

The second gas fan quenching cools the component sufficiently to avoid oxidising of its surface when it is removed from the heating device, into ambient atmosphere.

Components made from the alloy described in table II herein and repaired by the alloy achieved by mixing and heating the alloys disclosed in tables I and II as described hereinbefore, have been mechanically stress tested and have been found to possess those appropriate characteristics which are present in undamaged components made from the alloy in table II herein.

Claims

1. An alloy mix suitable for the repair of nickel based alloy components which are used in a high temperature environment comprises a first alloy, the constituents of which by weight are:

TABLE I

Al	2	-	3
Co	9	-	11
Cr	8	-	10
Fe	0	-	1.8
Hf	1.0	-	1.5
Ta	1.0	-	1.5
Ti	1.25	-	1.5
W	6	-	8
B	2.8	-	3.4
Y	0.001	-	0.02
Ni	Remainder		

mixed with a second alloy the constituents of which by weight are:

TABLE II

C	.13	-	.17
Al	5.25	-	5.75
B	0.01	-	0.02
Co	9.0	-	11.0
Cr	8	-	10
Hf	1.3	-	1.7
Ta	2.25	-	2.75
Ti	1.25	-	1.75
W	9.5	-	10.5
Zr	0.03	-	0.08
Ni	Remainder		

and wherein the weight percentage of the first alloy to the second alloy is in the range 60:40 to 50:50.

2. An alloy mix as claimed in claim 1 wherein the weight percentages of the first alloy to the second alloy is 60:40.

3. An alloy is claimed in claim 1 or claim 2 wherein the first and second alloys are in powder form.

4. An alloy as claimed in claim 3 wherein the grain size of the powders is less than 106 um.

5. A method of repairing score marks and/or fissures in a component made from an alloy the constituents of which are

C	.13	-	.17
Al	5.25	-	5.75
B	0.01	-	0.02
Co	9.0	-	11.0
Cr	8	-	10
Hf	1.3	-	1.7
Ta	2.25	-	2.75
Ti	1.25	-	1.75
W	9.5	-	10.5
Zr	0.03	-	0.08
Ni	Remainder		

comprising the steps of applying to said score marks and/or fissures, a mixture of a first powdered alloy the constituents of which comprise

Al	2	-	3
Co	9	-	11
Cr	8	-	10
Fe	0	-	1.8
Hf	1.0	-	1.5
Ta	1.0	-	1.5
Ti	1.25	-	1.5
W	6	-	8
B	2.8	-	3.4
Y	0.001	-	0.02
Ni	Remainder		

and a second powdered alloy, the constituents of which are as those of the component, which mixture is bound by an acrylic or water based binder, heating and then cooling the component in an inert atmosphere so as to effect brazing of the mixture to the component in said inert atmosphere and effect diffusion of the mixture and the component material across the interface therebetween.

6. A method of repairing score marks and/or fissures in a component as claimed in claim 5 wherein said heating and cooling steps comprise:

a) Heat in an inert atmosphere to 450°C and hold for 30 minutes.
b) Increase heat to 950°C and hold for 30 minutes.
c) Increase heat to 1190°C and hold for 30 minutes.
d) Quench by inert gas to a reduced temperature of 900°C
e) Re-heat to 1080°C at a rate of 50°C per hour and hold for 30 minutes.
f) Increase heat to 1140°C at a rate of 50°C per hour and hold for 30 minutes.
g) Increase heat to 1190°C at a rate of 50°C per hour and hold for 30 minutes.
h) Quench by,inert gas to below 100°C and then expose to room atmosphere and temperature.

7. A method of repairing a component substantially as described in this specification.

8. An alloy mix substantially as described in this specification.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 5640

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	GB-A-2 107 628 (ROLLS ROYCE LTD) * Page 1, lines 66-123 *	1-6	B 23 K 35/30 // B 23 P 6/04
A	EP-A-0 095 607 (GENERAL ELECTRIC CO.) * Claims 1,2; tables 1,2 *	1-6	
A	US-A-4 705 203 (C.C. McCOMAS) * Abstract *	1	
A	GB-A-1 449 273 (GENERAL ELECTRIC CO.) * Claim 1 *	6	
A	FR-A-2 296 491 (UNITED TECHNOLOGIES CORP.) * Claims 1-8; example 1 *	1	
A	EP-A-0 075 497 (SOCIETE NATIONAL D'ETUDE ET DE CONSTRUCTION DE MOTEURS D'AVIATION) * Claims 1-4,10 *	1	
A	BROWN BOVERI REVIEW, vol. 74, no. 10, October 1987, pages 593-599, Baden, CH; R. BÜRGEL et al.: "Experience gained refurbishing gas turbine blades"		TECHNICAL FIELDS SEARCHED (Int. Cl.5) B 23 K B 22 F F 01 D B 23 P C 22 C C 22 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15-09-1989	GREGG N.R.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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